Chapter 4

Evaluation Criteria

> **Chapter Highlights**
>
> Wetlands were evaluated from both engineering and biological perspectives.
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> The engineering analysis took into account hydraulic design and energy consumption.
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> The bottom line for treatment wetlands is 'do they consistently meet discharge permit requirements?'
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> The Montana Standardization was used by project biologists to compare the value of the constructed wetlands to resources found in natural wetlands.
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> Ancillary benefits at a wetland system may include educational, aesthetic and recreational components.

Evaluation of a Wetland

The Task Force members' varied backgrounds and the project team's technical expertise provided many perspectives on wetlands. The project team and the Task Force members selected standard criteria in order to provide a consistent framework for evaluating each wetland system. These criteria considered significant components of the wetland system.

The project team included both engineers and biologists in order to provide discipline-independent evaluations of the 'quality' of the wetland system. From an engineering perspective, a highly effective wetland system is one that can consistently meet its discharge requirements with minimal operational, maintenance, and energy requirements.

Biologists evaluated each wetland's value from an ecological perspective. From a biological viewpoint, higher quality wetlands provide habitat value and biological diversity, similar to natural systems.

Engineering Analysis

Team engineers catalogued the engineering related design components. These components include:

Hydrology

The hydrology in a constructed wetland system is determined by design rather than by climatic and groundwater influences. The general types of constructed wetlands are free water surface and subsurface flow wetlands. In a free water surface wetland, the water level is maintained above the ground level. In a subsurface wetland the water level is maintained below the surface of the ground. (See Chapter 2 for further details).

Hydraulics

The hydraulics will determine how wastewater is introduced into and conveyed through the wetland system. These system components include inlet piping systems, mechanisms to control the water depth in the wetland cells, and systems to collect and discharge the treated effluent at the end of the wetland cell.

Soil

Soils provide two main functions in a wetland system: to provide a consistent hydraulic conductivity and detention time for design flows, and to maintain and encourage plant growth. Soil may be native or a commercial mix containing soil amendments. The specified soil mix may consist of a specific particle size and type. Inorganic media may be used in place of organic soil to prevent the introduction of **noxious weeds**.

A noxious weed is a species of plant considered undesirable in a specific ecosystem. These plants tend to dominate an area and can cause liner punctures, plugging of flow, excessive shading, excessive water and nutrient consumption, and can minimize biological diversity in wetland systems.

Water Quality

Water quality requirements are the first concern when selecting a treatment method. Pollutants in the wastewater may limit the type of treatment that a community can implement. The focus of this study was small-flow municipal treatment facilities with fairly typical domestic and commercial waste. These communities did not have special conditions that would warrant a highly technical removal process.

The ultimate efficacy of the wetland is judged by its ability to meet permit requirements. Included in the Colorado Department of Public Health and Environment (CDPHE) permit files are the monthly Discharge Monitoring Reports (DMR's) that facilities must submit to ensure that they are meeting permit requirements. This water quality data provides a historical perspective of how the system is functioning. Since data are generally not available for water going into the wetland system, the water quality data are a measure of the effectiveness of the entire treatment system. These records were used to:

- Evaluate the long term performance of the system,
- Determine how the system effectiveness was altered by adding a wetland, when sufficient data were available from both before and after wetland implementation,
- Determine if the wetland system was consistently meeting discharge effluent requirements.

Energy Analysis

A primary focus of this inventory was to determine the energy savings experienced by using a constructed treatment wetland instead of conventional treatment methods. This discussion presents typical energy requirements for a selection of treatment methods.

A wide number of treatment methods will be able to meet the requirements to cleanse the effluent from theses typical systems. Financing often determines the selection of the most appropriate treatment method. Financing includes such things as operation, maintenance, capital costs, and energy expenditures. With rising energy costs, this component may become a predominant factor in selecting a treatment method.

Every treatment process uses the same amount of energy to physically remove, chemically breakdown, and biologically decompose pollutants per unit quantity. The significant difference between conventional treatment processes and natural treatment processes is the energy source. Conventional treatment systems use electricity and fuel to mechanically remove pollutants, speed-up biological processes, and act as catalysts in chemical processes. Natural systems rely on energy from the sun, gravity, and naturally occurring carbon sources to provide the energy necessary for physical, biological and chemical removal processes to take place.

A study undertaken by Middlebrooks, et al.[1], compared electrical and fuel energy requirements of conventional and land treatment alternatives. The following table shows typical energy requirements of six common treatment systems for a small treatment facility (0.5 mgd capacity).

Energy Requirements: 0.5 mgd System Capacity	
Treatment Type	Kilowatt Hours per Year
Trickling filter	106,500
Rotating biological contact facility (RBC)	111,000
Activated sludge with digestion	222,400
Activated sludge with sludge incineration	248,500
Activated sludge with advanced treatment	1,029,400

A wetland system generally has four components: preliminary treatment (bar racks), primary treatment (generally lagoon systems or septic tanks), the wetland, and finally disinfection. Some typical energy expenditures might include:

- Lift stations
- Grinders
- Aerators in the lagoon
- Automatic sampling and flow measurement devices
- Disinfection system (UV system, chlorine meters, etc.).

Since, the wetland cells themselves do not typically require external energy inputs, the energy efficiency of a system using wetlands will be greatly affected by the other treatment components.

[1] Middlebrooks, E.J., Middlebrooks, C.H., Reynolds, J.H., Watters, G.Z., Reed, S.C., and George, D.B. *Wastewater Stabilization Lagoon Design, Performance and Upgrading*. Macmillan Publishing Co., Inc., New York, NY. 1982.

How Much Energy Do We Normally Use?

We all use energy and rely on it for a large part of our lives. But do we know how much we use? A typical house uses approximately 8,760 KW/year. For a small community of less than 6500 people, you would need approximately 12 times that amount to fuel a trickling filter treatment system, and 117 times that much to operate an advanced treatment activated sludge facility.

As future reserves of energy are depleted, we need to look for alternative, low-cost methods to clean our water. Wetlands offer a viable, low-cost, low-energy alternative to traditional methods.

Design

Each site was evaluated for design goals and methodology. Since the wetlands in this study are used for treatment, the primary design goal was treatment of the wastewater to meet permit effluent requirements. The area needed to reach these effluent requirements determines the size of the wetland. The shape of the wetland is not as critical to the treatment functionality. The majority of wetlands inventoried were rectangular. Although rectangular wetlands are perceived to be easier to design and build, wetlands with irregular borders provide additional benefits without detracting from the treatment capabilities of the wetland itself.

The hydrology of a wetland system is the single most important design issue when creating a wetland. Free water surface wetlands are designed to allow the water to pond at the surface of the wetland cells to a depth ranging from six inches to several feet. In subsurface wetlands, the water level flows through the wetland media several inches below the surface of the wetland. The level of saturation in the wetland is vital for maintaining plant health. Allowing conditions in the wetland to become too dry or the water level to become too high will seriously impact the wetland plants. During site visits, the water depth and ability to change the water level was recorded.

The hydraulics of the system include the methods of conveying water into, through, and out of the wetland system. For each site the conveyance methods and operational experiences were recorded.

Biological Perspective

Wetlands function in treating wastewater through biological and chemical processes. Water cleansing depends on reduction/oxidation, or redox chemical reactions, in which metabolism by soil microorganisms and vegetation play a role. A healthy vegetative and microbial community is vital to the functioning of treatment wetlands. The biological health of a treatment wetland also plays an important role in its capacity to provide wildlife habitat and vegetative and landscape diversity.

To gain a biological perspective of treatment wetlands included in the study, researchers selected several key parameters, including vegetative cover, the number of plant communities in each cell, the amount of open water or bare soil, the vegetative structural diversity, wildlife habitat, and the presence of noxious weeds. These are all parameters that make a treatment system more valuable from a biological perspective and in turn, an aesthetic and socioeconomic perspective.

Montana Standardization

For each treatment wetland, project biologists evaluated wetland functions using the Montana Wetland Field Evaluation Form and Instructions (Montana Department of Transportation 1996). The “Montana Method” is an evaluation method that combines the U.S. Fish and Wildlife Service classification system (Cowardin et al. 1979) with a hydrogeomorphic (HGM) approach (Brinson

“Energy consumption is a major factor in the operation of wastewater treatment facilities. Many of the plans for water pollution management in the United States were developed before the cost of energy and the limitations of energy resources became serious concerns for the nation. As wastewater treatment facilities are built or updated to incorporate current treatment technology and to meet regulatory performance standards, energy must be a major consideration in designing and planning facilities.”

Reed, Sherwood C., Crites, Ronald W., and Middlebrooks, E.Joe. *Natural Systems for Waste Management and Treatment*. McGraw-Hill, Inc., Inc., New York, NY, 1995.

1993). The Montana Method provides a landscape context to the U.S. Fish and Wildlife Service classification. It is a rapid functional assessment process designed primarily to address wetland resources. The Montana Method, along with other standard methods of assessing wetland function and values, is designed to assess natural wetlands. Because treatment wetlands differ from natural wetlands, some of the function and value parameters were not included in the study, such as flood attenuation and storage, groundwater recharge and discharge, sediment/shoreline stabilization, recreation/education potential, and dynamic surface water storage. Also, project biologists did not complete Section 15A of the field evaluation form—*Habitat for Federally-Listed, Proposed, or Candidate Threatened or Endangered Plants or Animals* and *Section 15B—Habitat for Plants or Animals Rated S1, S2, or S3 by the Natural Heritage Program*. No federally listed, state listed, or Forest Service listed plant species are likely to occur in the treatment wetlands.

For each wetland, a function and value summary was prepared. The Montana Method provides a rating of low, moderate, high, or not applicable based on observations and responses to questions. Functional units were calculated without the use of area calculations. Additional site-specific information (vegetation, soils, and hydrology) was collected as part of the wetland assessment process.

The following is a brief description of the functions and values assessed (Montana Department of Transportation 1996).

Wildlife Habitat

General wildlife habitat potential of the assessment area based on perceived use by aquatic, semi-aquatic, and non-aquatic wildlife groups and habitat diversity as determined by the variety of wetland types.

Fish/Aquatic Habitat

Potential for the presence of fish in the assessment area is based on the known or suspected presence of native or introduced fish and the depth and duration of surface water at the site.

Sediment/Nutrient/Toxicant Retention and Removal

The ability of the assessment area to retain sediment and retain and remove nutrients and toxicants was based on the site's proximity to sediment/nutrient/toxicant sources; transport potential of these constituents to the assessment area via surface water; potential for the site to detain and retain the constituents; and potential of the site to filter and/or process (uptake) the constituents.

Production Export/Food Chain Support

The potential of the assessment area to produce and export food/nutrients for living organisms was evaluated. Production export typically refers to the flushing of relatively large amounts of organic material from the wetland to downstream habitats or adjacent deeper waters (Adamus, et al., 1991).

"Our hunch is that, at least in surface flow wetlands, habitat quality and water treatment function are closely related, in that many of the same things that enhance habitat quality also tend to improve water treatment function."

Sartoris, James J. and Thullen, Joan S., "Developing a habitat-driven approach to CWWT design." Proceedings from Engineering Approaches to Ecosystem Restoration ASCE Conference, March 22-27, 1998, Denver, Colorado.

Uniqueness

Includes the general uniqueness of the assessment area relative to the abundance of similar sites occurring in the same major watershed basin, the replacement potential and habitat diversity of the assessment area, and the degree of human disturbance in the assessment area.

Human Use and Aesthetics

The primary goal of treatment wetlands is to treat wastewater. Wetland treatment systems have unique properties that differ from those of most conventional treatment methods. These unique properties provide ancillary benefits that can be enjoyed by the local community. Constructed treatment wetland sites offer educational experiences to schoolchildren, groups and individuals. These sites are ideal settings for viewing wildlife, discussing wastewater treatment processes, and educating the public on the importance of wetlands in the water cycle. Constructed wetlands are also an attractive addition to the community. In contrast to conventional treatment systems, constructed wetlands provide aesthetic benefits and do not detract from the scenic beauty of many remote areas and often add to beauty of overused and overbuilt areas. The Colorado inventory identified constructed treatment wetlands that were along trails, used as a water feature at a park entrance, and part of scenic vistas. Each site was inventoried to record ways that the local community profited from these ancillary benefits.

Operation and Maintenance

Wetland systems are often touted as a low maintenance solution to wastewater treatment. However, like most any **treatment train** an operator is necessary to ensure that the system remains functional. In this inventory, the operator for each system was interviewed to determine the level of effort necessary to successfully operate each system. Maintenance issues included clearing pipes to prevent clogging, seasonal burning or harvesting of the wetland plants, repair of berms, and general problem solving. Wetland system operators must have proper licensing, take water quality samples, and submit reports to the CDPHE to ensure compliance with discharge permits.

A treatment train is a series of processes that make up a treatment system. System components are selected to achieve a desired level of treatment.

Overall Component of the Community

The system was evaluated for its overall function as a component of the community. The following questions were asked at each inventoried wetland:

- Does the wetland treatment system detract from scenic vistas?
- Is the system publicly supported?
- Are recreational opportunities, such as running trails, provided?
- Are educational groups hosted?
- Is the wetland facility a source of pride for the community?